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# NAVAL POSTGRADUATE SCHOOL

**MONTEREY, CALIFORNIA**

# THESIS

**BUSINESS CASE ANALYSIS OF FUTURE IMMERSIVE TRAINING ENVIRONMENT (FITE) JOINT CAPABILITY TECHNOLOGY DEMONSTRATION (JCTD)**

by

Jason G. Jeanpierre

September 2009

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Advances in technology have allowed the Armed Forces to approach training in ways that might enhance current training methods and experiences. Modeling and simulation is a key enabler of Pentagon activities in acquisition, analysis, experimentation, planning, test and evaluation, and training. In June 2009, General Mattis was quoted as saying; "Simulators using gaming technology currently available, can be resourced to replicate the close combat where we take most of our casualties under the most ethically bruising conditions" [1]. The Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD) is a program aimed at training Soldiers and leaders to be adaptable, capable of responding to rapidly changing situations, and attuned to cultural conditions, in addition to being proficient in high intensity combat operations. With FITE JCTD, it is proposed that virtual simulation could be used not only to train for relatively straight forward combat operations, but also to train the decision making and command and control skills that small unit leaders and Soldiers need in the current operating environment.

The purpose of this study is to analyze the cost savings, as well as other benefits associated with the execution of the FITE JCTD program. This thesis conducts a business case analysis (BCA), including a baseline analysis and an extensive sensitivity analysis focusing on the Return on Investment (ROI) of FITE JCTD and its capability to support transition decisions of FITE JCTD.

The analysis shows for both the 5 and 10-year time horizons, the United States Marine Corp (USMC) and the Army should invest in the Motion Reality Force Simulation (VIRTSIM). This program yielded an ROI of over 1700% for a 5-year time horizon, and over 3400% for a 10-year time horizon.


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# BUSINESS CASE ANALYSIS OF FUTURE IMMERSIVE TRAINING ENVIRONMENT (FITE) JOINT CAPABILITY TECHNOLOGY DEMONSTRATION (JCTD)

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Submitted in partial fulfillment of the
requirements for the degree of

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# ABSTRACT

Advances in technology have allowed the Armed Forces to approach training in ways that might enhance current training methods and experiences. Modeling and simulation is a key enabler of Pentagon activities in acquisition, analysis, experimentation, planning, test and evaluation, and training. In June 2009, General Mattis was quoted as saying; "Simulators using gaming technology currently available, can be resourced to replicate the close combat where we take most of our casualties under the most ethically bruising conditions" [1]. The Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD) is a program aimed at training Soldiers and leaders to be adaptable, capable of responding to rapidly changing situations, and attuned to cultural conditions, in addition to being proficient in high intensity combat operations. With FITE JCTD, it is proposed that virtual simulation could be used not only to train for relatively straight forward combat operations, but also to train the decision making and command and control skills that small unit leaders and Soldiers need in the current operating environment.

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# EXECUTIVE SUMMARY

Advances in technology have allowed the Armed Forces to approach training in ways that might enhance current training methods and experiences. Modeling and simulation is a key enabler of Pentagon activities in acquisition, analysis, experimentation, planning, test and evaluation, and training. In June 2009, General Mattis was quoted as saying; "Simulators using gaming technology currently available, can be resourced to replicate the close combat where we take most of our casualties under the most ethically bruising conditions" [1].

The Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD) is a program aimed at training soldiers and leaders to be adaptable, capable of responding to rapidly changing situations, and attuned to cultural conditions, in addition to being proficient in high intensity combat operations. With FITE JCTD, it is proposed that virtual simulation could be used not only to train for relatively straight forward combat operations, but also to train the decision making and command and control skills that small unit leaders and soldiers need in the current operating environment.

The purpose of this study is to analyze the cost savings, as well as other benefits associated with the execution of the FITE JCTD program for the USMC and Army. This thesis conducts a business case analysis (BCA), including a baseline analysis and an extensive sensitivity analysis focusing on the Return on Investment (ROI) of FITE JCTD and its capability to support transition decisions of FITE JCTD.

This report presents an overview of the FITE JCTD, comparative alternative technologies to FITE JCTD, a generic structure to use as a guideline for performing BCAs, and the application of that generic BCA structure to the FITE JCTD.

The BCA compared the current DoD training for small unit soldiers ("as-is") to what could be achieved ("to-be") with the FITE JCTD. Life Cycle Costs consists of investment cost to develop FITE JCTD, as well as, the cost to upgrade, administrate and maintain it.

For the USMC and Army, Motion Reality Force Simulation (VIRTSIM) is the best program to invest over both the 5-year and 10-year time horizon. This program yielded an ROI of over 1700% for a 5-year time horizon, and over 3400% for a 10-year time horizon. Examining the Army and USMC with respect to Dismounted Soldier Close Combat Tactical Trainer (DSCCTT), the Army yielded an ROI over 400% for the 5-year time horizon and over 900% for the 10-year time horizon, while the USMC yielded an ROI over 300% and 600% respectfully. Analyzing FITE JCTD, the Army yielded an ROI of over 800% for a 5-year time horizon, and 1600% for a 10-year time horizon, while the USMC yielded and ROI over 600% and 1200% respectfully.

The analysis conducted in this thesis shows that FITE JCTD is a financially viable and robust solution to the problem of not having immersive training venues or equipment for small unit combat. But, VIRTSIM is the leading candidate for investment of the future. Each program provides a high return on investment over a wide range of varying input factors and appears to be a worthwhile investment for the DoD.

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# I. INTRODUCTION

## A. PURPOSE OF STUDY

Advances in technology have allowed the Armed Forces to approach training in ways that might enhance current training methods and experiences. Modeling and simulation is a key enabler of Pentagon activities in acquisition, analysis, experimentation, planning, test and evaluation, and training. In June 2009, General Mattis was quoted as saying; "Simulators using gaming technology currently available, can be resourced to replicate the close combat where we take most of our casualties under the most ethically bruising conditions" [1]. The Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD) is a program aimed at training Soldiers and leaders to be adaptable, capable of responding to rapidly changing situations, and attuned to cultural conditions, in addition to being proficient in high intensity combat operations. With FITE JCTD, it is proposed that virtual simulation could be used not only to train for relatively straight forward combat operations, but also to train the decision making and command and control skills that small unit leaders and Soldiers need in the current operating environment. The purpose of this study is to analyze the cost savings, as well as other benefits associated with the execution of the FITE JCTD program. This thesis conducts a business case analysis, including a baseline analysis and an extensive sensitivity analysis focusing on the Return on Investment (ROI) of FITE JCTD and its capability to support transition decisions of FITE JCTD.

FITE JCTD is joint sponsored and holistically integrates the technological advances across the Department of Defense and other government agencies. The JCTD will enhance and integrate existing, planned, and emerging programs and technologies such as Aviation Combined Arms Tactical Trainer (AVCATT), Military Operations on Urban Terrain (MOUT), Motion Force Reality Simulation (VIRTSIM), and Mojave Viper, a service level training exercise conducted by the Marines. FITE JCTD will demonstrate an immersive training environment, which sets conditions for deployable

training systems, home station training, mission planning, and rehearsal by replicating the effects and conditions of the operational environment. Immersive training systems that enhance skills are key enablers for training [2].

FITE was officially launched October 2008 through a directive from the Under Secretary of Defense, Advance Systems and Concepts, John J. Kubricky, and is a two-year, $36 million initiative sponsored by the United States Joint Forces Command (USJFCOM). Other defense organizations participating include the Joint Improvised Explosive Device Defeat Organization (JIEDDO), the United States Special Operations Command (USSOCOM), the Office of the Deputy Under Secretary of Defense, Advanced Systems and Concepts (DUSD/AS&C), and the United States Army, Marine Corps, Air Force, and Navy.

George Solhan, Office of Naval Research ONR's Deputy Chief of Naval Research for Expeditionary Maneuver Warfare and Combating Terrorism, believes that leading-edge training technologies will enable small units to dominate the future battlefield. General James N. Mattis, commander, USJFCOM, has challenged his Joint Warfighting Center (JWFC) to take "a giant leap forward in our simulated training environment for small units in ground combat to enable advances on the ground similar to the manner in which we have gained air, space and maritime dominance" [1]. On March 18, 2009, General Mattis explained the need for FITE JCTD. General Mattis said,

> Today, our ground combat forces suffer more than 80 percent of our casualties and we can provide them with high quality live, virtual, and constructive simulation capabilities to reduce this risk. Mixing brick and mortar surroundings with live actors and interactive virtual tools will provide unprecedented realism for our ground troops and better replicate the chaos of the 'first fights' so our youngest warriors are prepared for the tactical and ethical demands of combat among non-combatants. [1]

## B. SITUATION

The operational environment requires forces capable of full spectrum operations. The current and future conflicts may be borderless or exist within small, urbanized areas and may require our troops to respond with certain skills or capabilities not yet fielded. Improved decision-making skills are essential where tactical actions have strategic

implications. As a result, future training environments will need to incorporate improved training technologies. Immersive training systems will only enhance our troops' capabilities to make quick and sound decisions.

Military trainers lack sufficient immersive tools and procedures to train close combat tasks in a realistic fully immersive training environment to create and reinforce complex situation awareness and decision making skills. There are insufficient enablers to provide an immersive environment with adequate decision-making stimuli for infinitely repeatable and rapidly reconfigurable scenarios. Concurrently, there is a lack of high fidelity virtual entities to provide resource effective, complex population based training environment to observe, orient, decide, act (OODA) under the conditions of sensory overload.

## C. OBJECTIVE

The objective of FITE JCTD is to provide military trainers and trainees with a cost-effective, flexible, and realistic immersive training environment that creates and reinforces complex (tactical and human dimension) decision-making skills. Also, to deliver a system that accurately replicates cultural and behavioral sensitivities in repeatable and rapidly reconfigurable scenarios that can be quickly configured to match a variety of potential operational environments.

## D. DESIRED CAPABILITES

The immersive training environment should replicate elements of the visual, audio, tactile, olfactory, effects and conditions of the battlefield across the full spectrum of operations, in order to improve cognitive skills. The training environment should also provide culturally realistic, reactive, dynamic, and synthetic entities that allow realistic interaction within the Common Operating Environment (COE). Team members from Army Soldiers to Marine Corp squads must have the capability to exercise complex kinetic and nonkinetic and human dimension decision making under stressful conditions. The desired capabilities of FITE JCTD are listed below [2]:

- Trainee feedback—interaction between trainees and their environment will be instantaneous and in stride. Training will be responsive to interactions with entities through kinetic and nonkinetic means. Feedback from the trainee will reduce negative training aspects and ensure the systems maintain real time, physically accurate representation of kinetic effects and nonkinetic effects.
- Joint enablers—within the service C2 (Command and Control) architecture, these enablers will allow the trainee to request, control and coordinate supporting arms and Intelligence, Surveillance, and Reconnaissance (ISR) within the training scenario as appropriate to squad level operations.
- Collective After Action Review (AAR)— will capture lessons learned and ensure the best use of training resources. The capability will record and playback each entity's movements, orientation, and communications. Support a user-friendly interface that facilitates collective AARs, real time exercise monitoring and rapid trend analysis capability.

## E. RESEARCH METHODOLOGY, GUIDELINES, AND ASSUMPTIONS

To achieve the objectives and desired capabilities set out in Sections C and D, the author uses an analytical structure for performing business case analyses (BCA). The BCA for the FITE JCTD will then be conducted based on that structure, results reported, with appropriate recommendations reported for decision makers. The comprehensiveness of the BCA presented is necessarily limited to the data and information made available to the author. However, the method that estimates cost saving and benefits obtained specific to the operational scenario can be also used to derive the savings and benefits for other, reasonably similar cases. Key guidelines and assumptions while performing the BCA are as follows:

- Alternatives identified with the following information:
  - Benefit/cost data identified and analyzed as consistently available across JCTD and alternatives.
  - Alternatives fully funded with a Technology Readiness Level (TRL) 7 or greater.
- Operations and maintenance (O&M) funding required consists of labor, spares, repairs, etc.
- Compare acquisition components for FITE JCTD and alternatives.

- All costs adjusted for inflation using Naval Center for Cost Analysis (NCCA) indices.
- Analysis time frame is FY08-FY09.
- Define Work Breakdown Structure (WBS) for O&M.
- Define extrication/retirement costs.
- Define Research, Development, Test and Evaluation RDT&E/Procurement costs (license, documentation, installation, training, security, etc.).

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# II. BACKGROUND

This chapter provides an overview of the technologies that are currently employed. It also includes new technologies that are being developed. A summary of the Joint Capability Technology Demonstration (JCTD) Program is also provided here. Finally, the chapter concludes with an overview of the Business Case Analysis (BCA) methodology.

## A. CURRENT TECHNOLOGIES

### 1. Motion Reality Force Simulation, Virtual Simulation (VIRTSIM)

The VIRTSIM system immerses up to 12 squad members and 1 trainer/officer in visually accurate, live combat scenarios requiring real-time individual-, team-, and squad-level fire and maneuver. This total immersion training system provides training in a variety of increasingly complex scenarios of the commander's choice, in which the trainees' actions or inactions bring real-time consequences—good, bad, and lethal—as they would in a firefight. Unlike screen and other simulators, the trainee's entire body is immersed in, and is part of, the combat. Now trainees are vulnerable to 360-degree threats from snipers, ambush teams, explosive devices, and even friendly fire. Figure 1 shows the basic setup of VIRTSIM, which is 50′ x 100′ x 15′.

Figure 1. VIRTSIM Base Setup (From: [4])

VIRTSIM advantages are [4]:

- Physical and cognitive stress is experienced simultaneously.
- Wireless stereo head-mounted display provides each trainee with his or her own, independent, 360-degree view of the scenario.
- High throughput squad-level training allows approximately 1,000 soldiers to be trained every 40 hours.
- VIRTSIM systems can be networked together to allow groups at different facilities to train in the same virtual environment in real time via an Internet connection.

VIRTSIM has numerous savings. First, facility costs; there is no longer a need to build new training facilities (i.e., no Military Construction [MILCON] required) nor to maintain or repair those damaged from extensive training. Second, ammunition cost; significant savings are realized from reduced time spent in live-fire training, as well as savings on ammunition during VIRTSIM training, since weapons are battery powered. Third, transportation costs are reduced through the use of networks. Systems can be networked to allow groups in the same or at different locations to conduct real-time training within the same virtual environment. This minimizes transportation personnel for specialized training by providing increased home-station training capabilities. Lastly, savings to the environment; VIRTSIM simulates live ammunition firefights, improvised explosive device (IED) explosions, and other destructive combat activities without the recurring cost of repairs due to collateral damage to the training environment.

### 2. Military Operations on Urban Terrain (MOUT)

MOUT is defined as all military actions that are planned and conducted on a terrain complex where man-made construction affects the tactical options available to the commander. [4] MOUT training is conducted at Combined Arms Collective Training Facilities (CACTFs), Shoot Houses (SHs), and Urban Assault Courses (UACs).

The CACTFs are designed to provide individual through battalion level, home station, and urban operations training. These new training facilities allow units to train soldiers on building entry and room clearing techniques under live and blank fire

conditions and limited training in an urban training facility large enough to conduct combined arms, force-on-force collective training at the battalion and task force level. Figure 2 is an example of a CACTF.

Figure 2. Combined Arms Collective Training Facility (From: [5])

The CACTF is a complex of buildings covering an urbanized area of 2.25 square kilometers. It provides the trainees and trainers with audio and video instrumentation, three-dimensional precision targets, after action review, and non-precision targets.

The SH provides a facility to train and evaluate the unit during a live-fire exercise. Units are trained and evaluated on their ability to move tactically, engage targets, conduct breaches, and practice target discrimination. Figure 3 is an example of an SH.

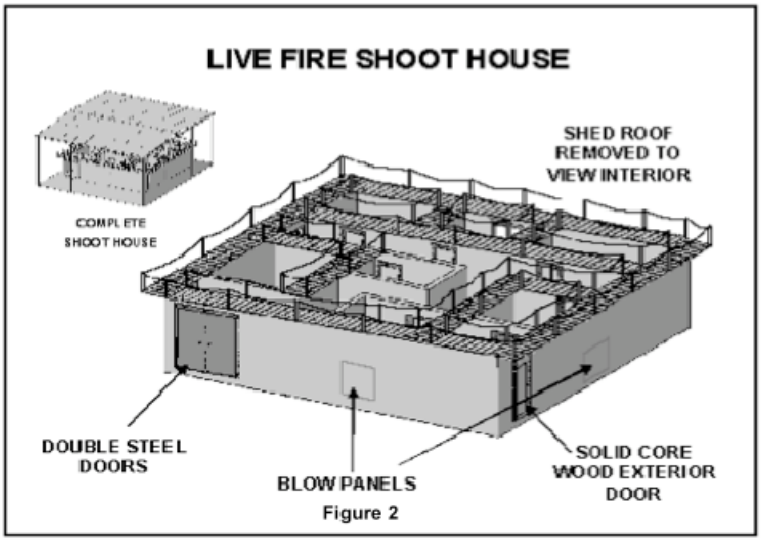


Figure 3. Live Fire Shoot House (From: [7])

All targets in the SH are fully automated and the event-specific target scenario is computer driven and scored from the range operations center. The range operating system is fully capable of providing immediate performance feedback to the trainees. All targets are life-like, precision targets that have reconfigurable plug-and-play capability.

Finally, training is conducted at the UAC. This facility is used to train individual soldiers, squads, and platoons on tasks necessary to operate within a built-up urban area. It contains five stations: Individual and team trainer, squad and platoon trainer, urban offense and defense building, and underground trainer. UAC is designed to be recommended training prior to using the SH or CACTF. Figure 4 depicts these stations.

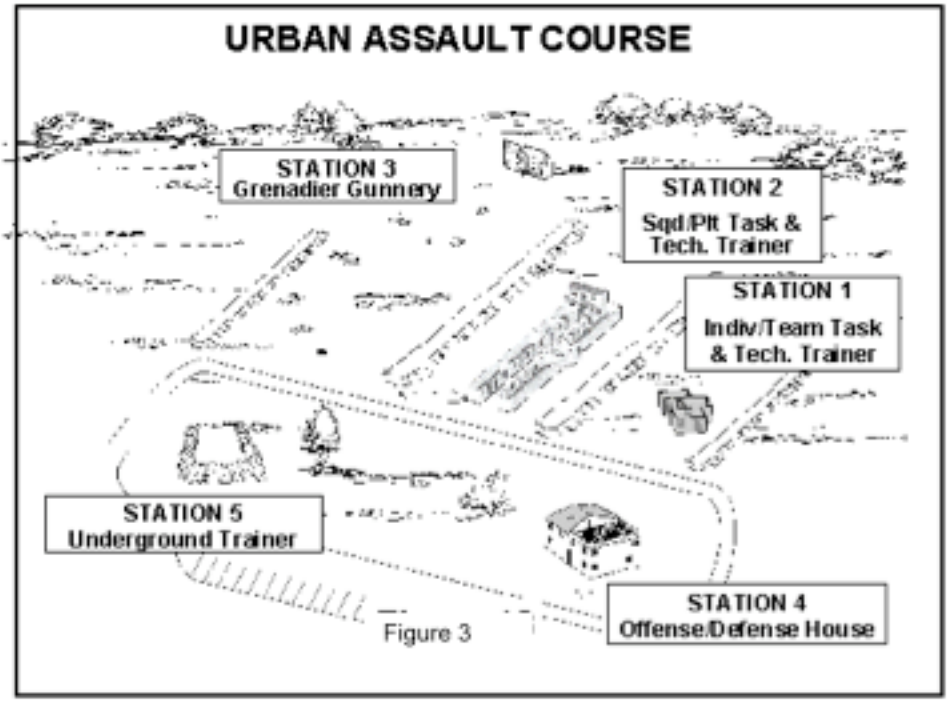


Figure 4. Urban Assault Course (From: [7])

## B. JOINT CAPABILITY TECHNOLOGY DEMOSTRATION (JCTD)

The JCTD is partly related to the Advanced Concept Technology Demonstration (ACTD) program, which was created by the Department of Defense (DoD) in 1994 [8]. Before the use of JCTD, ACTD was used as the structure to evaluate programs.

### 1. The ACTD Program

The Deputy Undersecretary of Defense (Advanced Technology) (DUSD/AS&C) has oversight responsibility for the ACTD program. He is responsible for developing and promulgating guidance regarding the ACTD program, for evaluating candidates and approving new ACTDs, and for providing oversight, support, and evaluation of on-going ACTDs. ACTDs exploit mature, advanced technologies to develop solutions for important military problems. A declining budget, significant change in threats, and acceleration in the pace of technology have created challenges to our ability to address significant military needs. In addition, global proliferation of military technologies—and potential adversaries with relatively easy access to these technologies—has increased the

need to rapidly transition new technology from the developer to the user. The ACTDs are structured to address the needs of the war fighter by providing needed capabilities, addressing deficiencies, and reducing costs or manpower requirements. Each ACTD is aimed at one or more war-fighting objectives and is reviewed by the Services, Defense Agencies, and the Joint Staff. Candidates are proposed for initiation in each fiscal year and are reviewed for technical maturity and projected effectiveness. Those with the greatest potential are submitted to the Joint Staff/Joint Requirements Oversight Council (JROC) for prioritization.

ACTDs can be characterized by their employment of mature technologies over a fixed period of activity. They can also leverage existing technological investments. There is also a residual capability after the completion of the ACTD demonstration. In addition, ACTDs focus heavily on joint operations with Combatant Command war-fighter participation, as well as a significant level of cross-service, cross-agency organizational involvement.

The guidelines developed to provide guidance for the selection criteria for ACTD candidates are [9]:

- The time for complete evaluation of military utility is about 2-4 years.
- The technology should be sufficiently mature.
- The project shall provide a potentially effective response to a priority military need.
- A lead service or agency has been designated.
- The risks have been identified, are understood, and accepted.
- Demonstrations or exercises have been identified that will provide an adequate basis for the utility assessment.
- Funding is sufficient to complete the planned assessment of utility and to provide technical support for the first two years of fielding the interim capability.
- The developer is ready to prepare a plan that covers all essential aspects. These include affordability, interoperability, sustainability, evolutionary capability, and threat changes.

The objectives of ACTDs are to conduct meaningful demonstrations of military utility, develop and test concepts of operations (CONOPS) to optimize military effectiveness, and prepare to transition to acquisition without loss of momentum. Another major ACTD goal is to promote operational "jointness" to reach beyond individual Service interests and capabilities for integrated, joint missions. The interests of the war fighter are paramount and, therefore, "guidelines" regarding ACTDs mentioned above are considered flexible. Last, but not least, the ACTD is to provide a residual capacity to further refine CONOPS and to permit continued use prior to formal acquisition, as well as to provide the ability to proceed into formal acquisition for additional capability, if required.

Possible outcomes after the ACTD operational demonstration are [8]:

- The user/sponsor may recommend acquisition of the technology and field the residual capability that remains at the completion of the demonstration phase of the ACTD to provide an interim and limited operational capability.

- If the user's need is fully satisfied by the residual capability remaining at the conclusion of the ACTD, there is no requirement to acquire any additional units of the system.

- If the capability is deemed to not demonstrate sufficient military utility, the project is terminated or returned to the technology base for further development.

### 2. The JCTD Program

The JCTD model was initiated and takes a successful ACTD program and modifies it to better meet DoD's transformational goal of becoming capability based. This capability-based approach is intended to provide a faster and more integrated joint response that meets emerging asymmetrical threats. The JCTD model includes many positive aspects of the ACTD program and is integrated with the Joint Capability Integration and Development System (JCIDS) developed by the Joint Chiefs of Staff (JCS). JCTDs focus on joint and transformational technologies that are initiated in Science and Technology (S&T), and carried through the difficult transition stage. The new JCTD business model will also include a Defense Acquisition Executive (DAE) pilot

program that will take a limited number of "joint peculiar" JCTDs past milestone B, into procurement, followed by initial sustainment, which is essentially a "cradle-to-grave" approach.

The JCTD program is comprised of three possible transition models' post demonstrations [9]:

- **Transition to Program of Record (POR).** Once the military utility of the program has been successfully demonstrated, the warfighters will adopt the concepts. The technology or system will be transferred to a new/current POR or Government Services Administration (GSA) schedule. The acquisition of additional capability will also be funded.

- **Interim Capability to meet needs of the war fighter.** Same as above, however, the technology and system may or may not have been sent to a POR. This interim capability fully meets the war fighter's needs and is being maintained.

- **Return to technology base.** The military utility is deemed to have been unsuccessfully demonstrated. Relevant components or capabilities may be incorporated into other systems, returned to the technology base, or terminated.

## C. THE FUTURE IMMERSIVE TRAINING ENVIRONMENT JCTD

Capabilities provided from this JCTD are available for integration into the USJFCOM Live-Virtual Constructive suite of training tools that will extend and enhance training opportunities to the small unit, tactical level of warfare. Because FITE JCTD is also an approved JCTD, the outputs from this initiative are highly visible to the Services and positioned for rapid transition to their programs of record once demonstration is complete in FY11. FITE JCTD seeks to significantly increase training capacity and throughput by complimenting the limited number of traditional, resource-constrained, live-training environments with immersive, virtual training environments.

### 1. Summary and Payoffs

FITE JCTD will provide common enabling training technologies and capabilities to support a full range of training methodologies. FITE JCTD will provide the conditions to elevate the quality of training focused on decision making. Training capabilities focus on the reinforced squad training capability with integrated, interoperable, immersive

elements. It provides a more realistic, full sensory training environment. Small unit trainees will be provided with decision-making stimuli to exercise complex, fast-paced legal, moral, and ethical decision making, across the spectrum of kinetic and non-kinetic operations. It allows for increased home station training. FITE JCTD is designed to technically and operationally demonstrate and assess capabilities with war fighters and operators, and accelerate the transition to existing and proposed PORs.

### 2. Program Exit Criteria

The exit criteria for FITE JCTD are as follows [2]:

- Training capability with integrated, interoperable, immersive elements.
- Trainee feedback.
- Joint enablers.
- Collective After Action Review.

## D. BUSINESS CASE ANALYSIS (BCA)

A BCA is a basic financial tool used by decision makers to evaluate alternative approaches and to decide on the best courses of action, with due regard for allocation of scarce resources. The BCA, which is a reasonably well-structured and systematic methodology, provides a best-value analysis that considers not only cost, but also other quantifiable and nonquantifiable factors that are relevant to the investment decision.

The BCA framework is an iterative process that is updated as the business and mission environment changes. It consists of the following elements [10]:

- Determine objectives
- Specify assumptions and constraints
- Identify possible alternatives, including status quo
- Estimate cost and benefits of every alternative
- Perform sensitivity analysis and risk analysis
- Derive conclusions and make suitable recommendations

A sound and reliable BCA is an unbiased and objective analysis of the financial consequences of the various alternatives. The reliability of the BCA is crucial in aiding

the decision maker to make an informed choice. It is based on facts, reasonable assumptions, and sound financial principles, with its conclusions traceable and transparent whenever possible. As a decision-making tool, a high quality BCA process provides the decision maker with the relevant insights as to how the project supports the strategic objectives and how it can help achieve these objectives. This assessment is structured such that important information on the scope, alternatives, costs, and benefits are laid out clearly, with the potential risks highlighted so that the decision maker can make an informed decision on whether to invest in the project.

Every BCA differs in the objectives, assumptions, constraints, risk, and operation scenario; thus, it is natural to expect that each BCA be customized for the particular case within a specific operating environment. However, a generic BCA methodology can be described as a four-phased process, which are [10]:

- Definition
- Collection of data
- Analysis
- Presentation of results

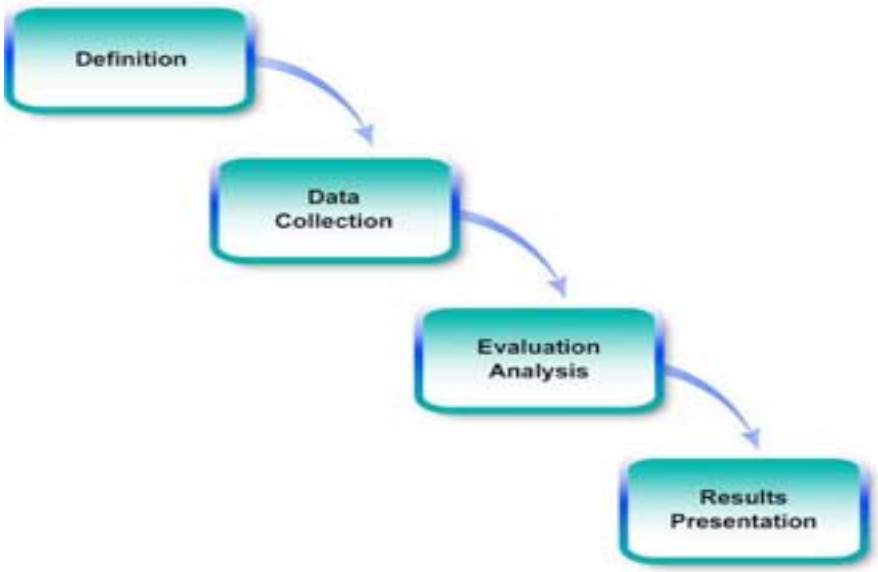


Figure 5. Business Case Analysis (BCA) as defined by the Defense Acquisition University (DAU) (From: [10])

The basic steps to the BCA process are:

### 1. Definition

In the first phase, definition, the scope, assumptions and constraints will be defined to guide the analysis. Alternative options are also explored to ensure that there is a minimum of two outcomes available at the end of the analysis.

### 2. Collection of Data

In the second phase, collection of data, a data collection plane is devised so that the types of data required, the data sources, and how they can be obtained, can be mapped out. Models will also have to be developed so that the data can be categorized and stored, while preserving the data integrity. Data normalization is also applied where required. Where the data is not available, estimates can be made, as long as they can be justified, and the methodology adopted explained clearly.

### 3. Analysis

The third phase, analysis, is where most of the BCA calculations are being accomplished. Data analysis is performed to build the case for each alternative. Each alternative is compared against the baseline so as to determine which one provides the best value. Risk analysis must be performed to identify the set of risks associated with each alternative, along with proposed risk-mitigating strategies. Sensitivity analysis aims to provide insights to the BCA results if the input parameters change, or if assumptions change or are proven invalid.

### 4. Presentation of Results

In the final phase, presentation of results, the BCA results are summarized into appropriate graphs and tables for representation to decision makers. The information presented should be concise, with relevant supporting evidence from the previous phases. A conclusion and recommended course of action should also be provided to the decision maker based on the objectives defined in the first phase. The BCA should be able to determine the following:

- Relative costs and benefits of various alternatives.
- Methods and rationale used to quantify benefits and costs.
- Influence and values of performance, cost, schedule, and sustainment trade-offs.
- Data required in support and justification of the decision.
- Sensitivity analysis of assumptions.
- Risk analysis of the recommended decision.
- Recommendation and summary of the implementation of the decision for proceeding with the best value alternative.

# III. FUTURE IMMERSIVE TRAINING ENVIRONMENT (FITE) BUSINESS CASE ANALYSIS

## A. THE BUSINESS CASE ANALYSIS, RUNNING THE NUMBERS

In this business case analysis, the life cycle costs, specifically, investment, operations, and maintenance, are examined.

### 1. Investment Costs

> Investment cost consists of the estimated cost of the investment phase, [which typically includes] the total cost of procuring the prime equipment, related support equipment, training, initial and war reserve spares, pre-planned product improvements and military construction. [11]

For this business case, we focused on the unit procurement costs and research and development cost.

### 2. Operations and Support Cost

> The O&S cost consists of the estimated cost of operating and supporting the fielded system, including all direct and indirect costs incurred in using the system, e.g., personnel, maintenance, and sustaining investment (replenishment spares). O&S cost is the recurring cost incurred to maintain the operational readiness of the system throughout the life cycle of the system. [11]

For this business case, we will focus on the estimated recurring maintenance costs and the sustaining investment costs. Also assuming the personnel costs are a part of the O&S cost.

### 3. Data

All baseline costs are provided in FY08$K. The source of all data was collected from the various programs being compared along with information from the Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD) Management and Transition Plan. Basic assumptions were made in order to facilitate analysis of the data. They are as follows:

- All R&D conducted in 1 year
- All procurement is conducted immediately after R&D
- All savings begin in 1st year after procurement
- O&S costs are 10% of procurement cost (exception MOUT-IMTS)
- Marine Corp Rifle company = 180 (Squad = 12)
- Army Company (Infantry) = 134 (Squad = 9)
- Discount factors used (0%, 1%, 3%, 5%)
- Time horizons are 5-year and 10-year

The following table is a collection of the initial data used to conduct the analysis. All values are in FY08$K.

| | Spiral 1 | MOUT (IMTS) | Dismounted Soldier | VIRTSIM |
|---|---|---|---|---|
| R&D | $12,175.00 | $20,300.00 | $750.00 | $0.00 |
| Procurement (per unit) | $55.00 | $244,476.00 | $92.00 | $3,412.92 |
| O&S [per yr] | $5.50 | $12,099.00 | $9.20 | $341.29 |

Table 1. Investment cost (R&D and Procurement costs) and O&S cost

The financial feasibility of the various programs listed above was evaluated on the basis of Net Present Value (NPV) and Return on Investment (ROI).

The NPV of an investment is defined as the sum of the present values of the annual cash flows. The annual cash flows are the Net Benefits (revenues minus costs) generated from the investment during its lifetime. These cash flows are discounted or adjusted by incorporating the uncertainty and time value of money. NPV is calculated as follows [12]:

$$NPV = \sum_{t=0}^{n} \frac{C_t}{(1-r)^t}$$

where

t – the time of the cash flow

n – the total time of the project

r – the discount rate

$C_t$ – the net cash flow at time

Discount rate is the rate used to discount future cash flows to their present values. An approach to choosing the discount rate factor is to decide the rate, which the capital needed for the project, could return if invested in an alternative venture. Discount rates of 0%, 1%, 3%, and 5% were examined.

Return on Investment is a performance measure that is commonly used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. It is a popular metric because if its versatility and simplicity. If an investment does not have a positive ROI, or if there are other opportunities with a higher ROI, then one can easily determine that the investment should not be undertaken. ROI works well in situations where both the benefits and costs of an investment are known and where they clearly result from the action. Additionally, ROI blends all the ingredients of profitability—revenues, costs, and investment, into a single percentage. Note though that the metric itself does not speak to the magnitude of returns or the risks involved. The ROI formula:

$$ROI = \frac{Income}{Investment}$$

In this case, the Income is equivalent to the savings produced from the O&S costs and the Investment is equivalent to the NPV investment cost. [13] For each ROI, the first 100% represents the initial investment in the program. For every percentage over the first 100%, it is an additional return to the initial amount invested.

## B. FIVE-YEAR COMPARISON OF ALTERNATIVES VS. MOUT (USMC)

The following charts are illustrations of NPV and ROI at various discount factors (0%, 1%, 3%, 5%) over a 5-year time horizon. At the end, each program is compared against each other, and based on the NPV and ROI, a choice of which program is ideal for the USMC is made.

### 1. Financial Metrics (5-year time horizon)

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $43,148.20 | POSITIVE, SO GOOD |
| ROI @ 0%(NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 349.27% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 249.27%. ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $41,547.51 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 342.42% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 242.42%. ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $38,570.85 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 329.5% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 229.5%. ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $35,865.55 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 317.56% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 217.56%. ATTRACTIVE |

Table 2. 5-year financial metrics of MOUT vs. DSCTT (USMC)

Table 2 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $55,716.91 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1732.53% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1632.53%. VERY ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $54,024.01 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1698.76% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1598.76%. VERY ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $50,864.70 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1635.1% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1535.1%. VERY ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $47,979.36 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1576.11% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1476.11%. VERY ATTRACTIVE |

Table 3. 5-year financial metrics MOUT vs. VIRTSIM (USMC)

Table 3 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is very attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $50,435.23 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 603.34% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 503.34%. ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $48,762.45 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 591.51% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 491.51%. ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $45,645.82 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 569.2% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 469.2%. ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $42,805.88 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 548.56% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 448.56%. ATTRACTIVE |

Table 4. 5-year financial metrics MOUT vs. Spiral 1 (USMC)

Table 4 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is attractive.

Table 2, 3, and 4 are the results of the total NPV and the ROI at the given discount factors over a 5-year time horizon for the USMC. Of the 3, VIRTSIM provides the highest NPV at 0% discount factor ($55,716.91) and ROI at 0% discount factor (1732.53%)

## C. TEN-YEAR COMPARISON OF ALTERNATIVES VS. MOUT (USMC)

The following charts are illustrations of NPV and ROI at various discount factors (0%, 1%, 3%, 5%) over a 10-year time horizon. At the end, each program is compared against each other, and based on the NPV and ROI, a choice of which program is ideal for the USMC is made.

## 1. Financial Metrics (10-year time horizon)

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $103,597.20 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 698.48% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 598.48%. ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $97,376.67 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 668.17% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 568.17%. ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $86,331.55 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 613.7% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 513.7%. ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $76,877.28 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 566.33% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 466.33%. ATTRACTIVE |

Table 5. 10-year financial metrics of MOUT vs. DSCTT (USMC)

Table 5 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $114,505.45 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 3455.06% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 3355.06%. VERY ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $108,319.62 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 3305.55% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 3205.55%. VERY ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $97,313.47 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 3036.9% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 2936.9%. VERY ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $87,864.54 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 2803.19% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 2703.19%. VERY ATTRACTIVE |

Table 6. 10-year financial metrics MOUT vs. VIRTSIM (USMC)

Table 6 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is very attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $110,920.33 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1206.97% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1106.97%. VERY ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $104,625.70 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1154.59% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1054.59%. VERY ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $93,437.02 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1060.5% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 960.5%. VERY ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $83,845.02 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 978.60% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 878.60%. VERY ATTRACTIVE |

Table 7. 10-year financial metrics MOUT vs. Spiral 1 (USMC)

Table 7 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is very attractive.

Table 5, 6, and 7 are the results of the total NPV and the ROI at the given discount factors over a 10-year time horizon for the USMC. Of the three, VIRTSIM provides the highest NPV at 0% discount factor ($114,505.45) and ROI at 0% discount factor (3455.06%).

As a result of the two different time horizons, the USMC has one course of action. It is in their best interest to invest in the VIRTSIM program.

## D. FIVE-YEAR COMPARISON OF ALTERNATIVES VS. MOUT (ARMY)

The following charts are illustrations of NPV and ROI at various discount factors (0%, 1%, 3%, 5%) over a 5-year time horizon. At the end, each program is compared against each other, and based on the NPV and ROI, a choice of which program is ideal for the Army is made.

## 2. Financial Metrics (5-year time horizon)

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $47,380.20 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 462.29% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 362.29%. ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $45,737.61 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 453.23% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 353.23%. ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $42,679.59 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 436.1% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 336.1%. ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $39,896.03 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 420.32% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 320.32%. ATTRACTIVE |

Table 8. 5-year financial metrics of MOUT vs. DSCTT (Army)

Table 8 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $55,716.91 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1732.53% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1632.53%. VERY ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $54,024.01 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1698.76% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1598.76%. VERY ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $50,864.70 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1635.1% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1535.1%. VERY ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $47,979.36 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1576.11% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1476.11%. VERY ATTRACTIVE |

Table 9. 5-year financial metrics MOUT vs. VIRTSIM (Army)

Table 9 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is very attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $52,982.83 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 807.36% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 707.36%. ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $51,284.40 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 791.54% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 691.54%. ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $48,118.01 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 761.7% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 661.7%. ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $45,230.26 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 734.05% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 634.05%. ATTRACTIVE |

Table 10. 5-year financial metrics MOUT vs. Spiral 1 (Army)

Table 10 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is attractive.

Table 8, 9, and 10 are the results of the total NPV and the ROI at the given discount factors over a 5-year time horizon for the Army. Of the 3, VIRTSIM provides the highest NPV at 0% discount factor ($55,716.91) and ROI at 0% discount factor (1732.53%).

## E. TEN-YEAR COMPARISON OF ALTERNATIVES VS. MOUT (ARMY)

The following charts are illustrations of NPV and ROI at various discount factors (0%, 1%, 3%, 5%) over a 10-year time horizon. At the end, each program is compared against each other, and based on the NPV and ROI, a choice of which program is ideal for the Army is made.

### 3. Financial Metrics (10-year time horizon)

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $107,829.20 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 924.51% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 824.51%. ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $101,566.77 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 884.39% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 784.39%. ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $90,440.29 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 812.3% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 712.3%. ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $80,907.75 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 749.59% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 649.59%. ATTRACTIVE |

Table 11. 10-year financial metrics of MOUT vs. DSCTT (Army)

Table 11 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $114,505.45 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 3455.06% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 3355.06%. VERY ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $108,319.62 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 3305.55% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 3205.55%. VERY ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $97,313.47 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 3036.9% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 2936.9%. VERY ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $87,864.54 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 2803.19% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 2703.19%. VERY ATTRACTIVE |

Table 12. 10-year financial metrics MOUT vs. VIRTSIM (Army)

Table 12 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is very attractive.

| FINANCIAL METRICS | | |
|---|---|---|
| TOTAL NPV @ 0% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $113,450.33 | POSITIVE, SO GOOD |
| ROI @ 0% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1614.66% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1514.66%. VERY ATTRACTIVE |
| TOTAL NPV @ 1% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $107,130.65 | POSITIVE, SO GOOD |
| ROI @ 1% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1544.59% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1444.59%. VERY ATTRACTIVE |
| TOTAL NPV @ 3% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $95,893.33 | POSITIVE, SO GOOD |
| ROI @ 3% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1418.7% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1318.7%. VERY ATTRACTIVE |
| TOTAL NPV @ 5% (NPV OF SAVINGS MINUS NPV OF INVESTMENT) | $86,254.54 | POSITIVE, SO GOOD |
| ROI @ 5% (NPV OF SAVINGS DIVIDED BY NPV OF INVESTMENT) | 1309.15% | YOU GET YOUR INVESTMENT BACK (THAT'S THE FIRST 100%), AND THEN AN ADDITIONAL 1209.15%. VERY ATTRACTIVE |

Table 13. 10-year financial metrics MOUT vs. Spiral 1 (Army)

Table 13 shows the total NPV and ROI at the various discount factor rates. The 0% discount factor yields the highest NPV and highest ROI. At the different discount factor levels, there is a positive ROI, and is very attractive.

Table 11, 12, and 13 are the results of the total NPV and the ROI at the given discount factors over a 10-year time horizon for the Army. Of the 3, VIRTSIM provides the highest NPV at 0% discount factor ($114,505.45) and ROI at 0% discount factor (3455.06%).

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# IV. CONCLUSION AND RECOMMENDATIONS

This report presented an overview of the FITE JCTD, comparative alternative technologies to FITE JCTD, a generic structure to use as a guideline for performing BCAs, and the application of that generic BCA structure to the FITE JCTD.

The BCA compared the current DoD training for small unit soldiers ("as-is") to what could be achieved ("to-be") with the FITE JCTD. Life Cycle Costs consists of investment cost to develop FITE JCTD, as well as, the cost to upgrade, administrate and maintain it.

The key results of the BCA are summarized as follows:

## A. OVERVIEW

- The FITE JCTD capabilities are intended to supplement current training methods rather than replace anything currently in use. FITE JCTD will demonstrate, and be independently assessed in the areas of complexity, realism and effectiveness of innovative immersive training system capabilities in support of small, ground based units. [14]
- FITE JCTD will provide conditions to elevate the quality of training focused on decision making. [2]

## B. FINANCIAL ANALYSIS

For both Services, VIRTSIM is the best program to invest over both the 5-year and 10-year time horizon.

Figures 6–8 illustrate the Total NPV versus the Total NPV at various discount factors over a 5-year time horizon for both Services. The analysis shows in each case, VIRTSIM yields the highest Total NPV compared to the other alternatives. In particular, there is no difference in Figure 6 between the USMC and Army; the results were the same for Total NPV for both Services

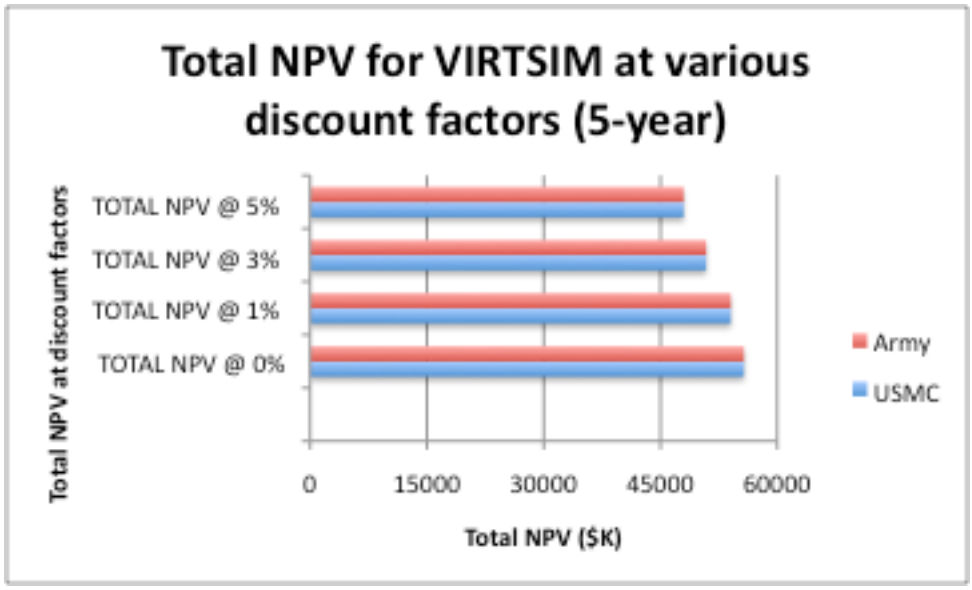


Figure 6. Total NPV for VIRTSIM at various discount factors (5-year)

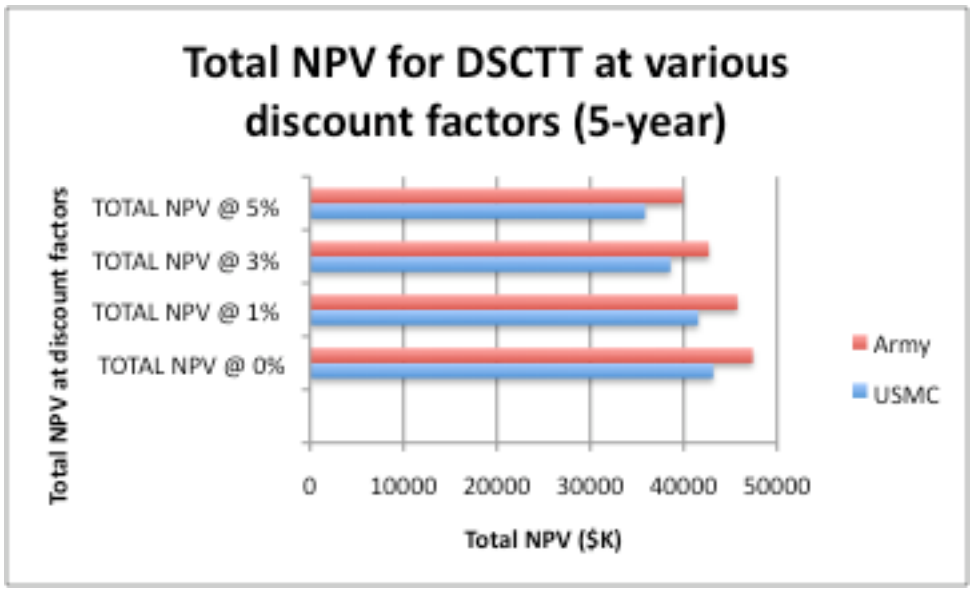


Figure 7. Total NPV for DSCTT at various discount factors (5-year)

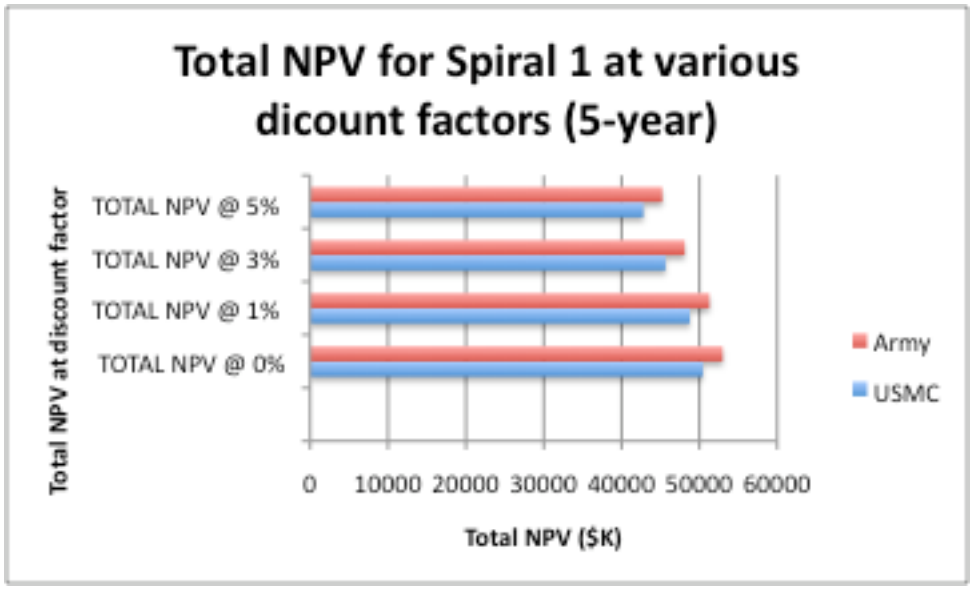


Figure 8. Total NPV for Spiral 1 at various discount factors (5-year)

Figures 9–11 illustrate the Total NPV versus the Total NPV at various discount factors over a 10-year time horizon for both Services. The analysis shows in each case, VIRTSIM yields the highest Total NPV compared to the other alternatives. In particular, there is no difference in Figure 9 between the USMC and Army; the results were the same for Total NPV for both Services

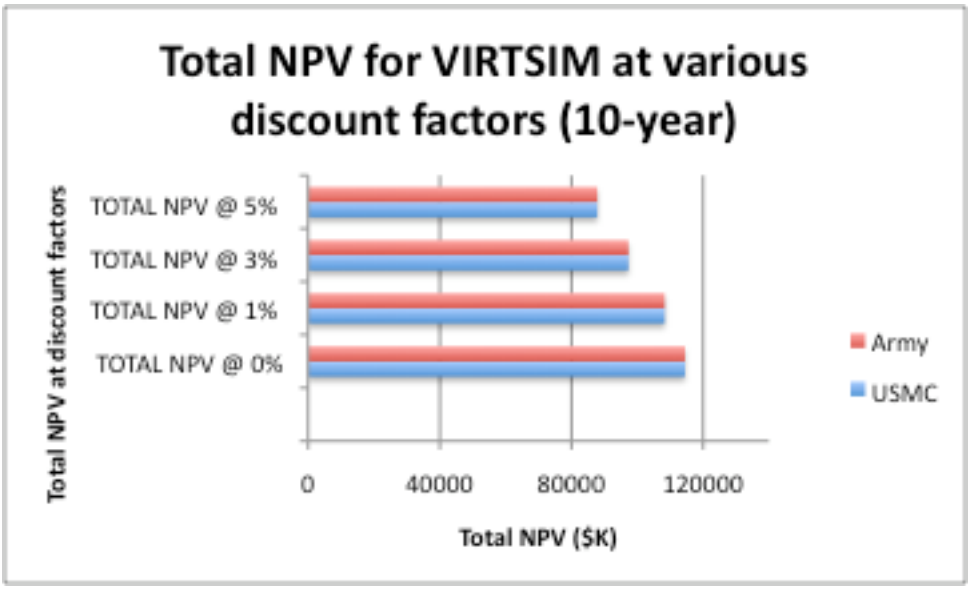


Figure 9. Total NPV for VIRTSIM at various discount factors (10-year)

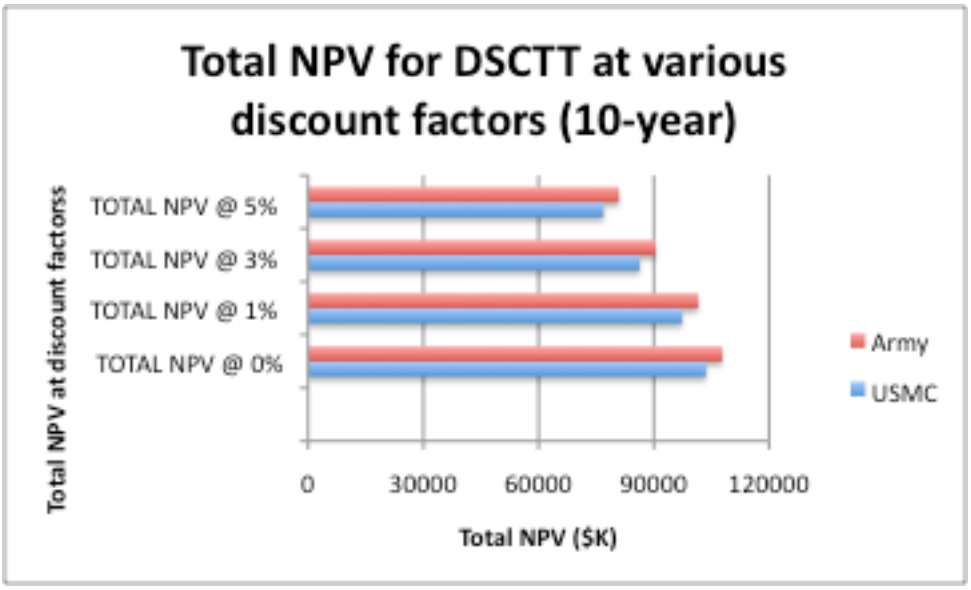


Figure 10. Total NPV for DSCTT at various discount factors (10-year)

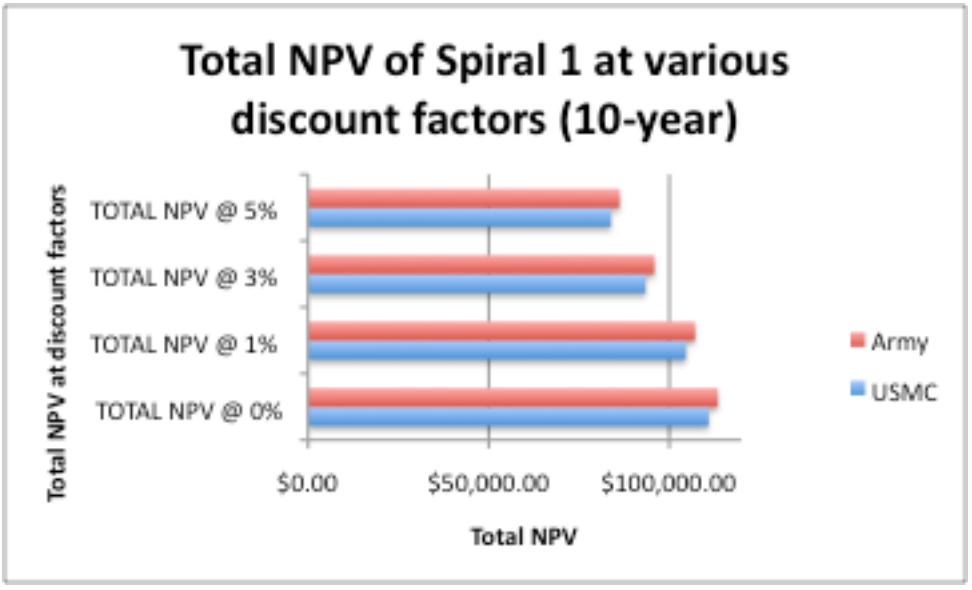


Figure 11. Total NPV of Spiral 1 at various discount factors (10-year)

## C. RISK ANALYSIS

The real risk involved with FITE JCTD is the potential for it not to be able to perform as advertised. Specifically [2]:

- Integrated, interoperable, immersive training elements
- Trainee feedback
- Joint Enablers
- Collective AAR

## D. BOTTOM LINE

The analysis conducted in this thesis shows that FITE JCTD is a financially viable and robust solution to the problem of not having immersive training venues or equipment for small unit combat. But, VIRTSIM is the leading candidate for investment of the future. Each program provides a high return on investment over a wide range of varying input factors and appears to be a worthwhile investment for the DoD.

## E. RECOMMENDATIONS FOR FUTURE RESEARCH

One area for future research is the potential cost savings FITE JCTD brings to commands via the home station training accomplished by FITE JCTD. Another area to be researched could be the benefits FITE JCTD accomplishes. Also, examining benefits and associating those benefits with quantifiable data could prove beneficial. Once the benefits are combined with the costs, FITE JCTD has potential to be extremely appealing to a command, organization and, ultimately, warfighter.

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# APPENDIX A DATA MOUT VS. DSCTT (5-YEAR) – USMC

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 |
|---|---|---|---|---|---|---|
| | R&D | 750 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 16,560 | 0 | 0 | 0 | 0 |
| | Total | 17310 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 0%) | 17310 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 17138.61386 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 16805.82524 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 16485.71429 | 0 | 0 | 0 | 0 |
| | Net Present Value @ 0% (NPV) | 17310 | | | | |
| | Net Present Value @ 1% (NPV) | 17138.61386 | | | | |
| | Net Present Value @ 3% (NPV) | 16805.82524 | | | | |
| | Net Present Value @ 5% (NPV) | 16485.71429 | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | DSS | 0 | 9 | 9 | 9 | 9 |
| | Savings | 12,099 | 12,090 | 12,090 | 12,090 | 12,090 |
| | Present Value (df @ 0%) | 12099 | 12089.8 | 12089.8 | 12089.8 | 12089.8 |
| | Present Value (df @ 1%) | 11979.20792 | 11851.58318 | 11734.24077 | 11618.06017 | 11503.02987 |
| | Present Value (df @ 3%) | 11746.60194 | 11395.79602 | 11063.87963 | 10741.63071 | 10428.76768 |
| | Present Value (df @ 5%) | 11522.85714 | 10965.80499 | 10443.6238 | 9946.30838 | 9472.674647 |
| | Net Present Value @ 0 % (NPV) | 60458.2 | | | | |
| | Net Present Value @ 1 % (NPV) | 58686.12191 | | | | |
| | Net Present Value @ 3 % (NPV) | 55376.67599 | | | | |
| | Net Present Value @ 5 % (NPV) | 52351.26896 | | | | |

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# APPENDIX B DATA MOUT VS. DSCTT (5-YEAR) – ARMY

| INVESTMENT | | FY10 | FY11 | FY12 | FY13 | FY14 |
|---|---|---|---|---|---|---|
| | R&D | 750000 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 12,328,000 | 0 | 0 | 0 | 0 |
| | Procurement (2 year span) | 6164000 | 6164000 | 0 | 0 | 0 |
| | Procurement (3 year span) | 4140000 | 4140000 | 4048000 | 0 | 0 |
| | Total | 23382000 | 10304000 | 4048000 | 0 | 0 |
| | | | | | | |
| | Present Value (df @ 0%) | 23382000 | 10304000 | 4048000 | 0 | 0 |
| | Present Value (df @ 1%) | 23150495 | 10100970.5 | 3928948.92 | 0 | 0 |
| | Present Value (df @ 3%) | 22700970.9 | 9712508.25 | 3704493.44 | 0 | 0 |
| | Present Value (df @ 5%) | 22268571.4 | 9346031.75 | 3496814.6 | 0 | 0 |
| | | | | | | |
| | Net Present Value @ 0% (NPV) | 37734000 | | | | |
| | Net Present Value @ 1% (NPV) | 37180414.5 | | | | |
| | Net Present Value @ 3% (NPV) | 36117972.6 | | | | |
| | Net Present Value @ 5% (NPV) | 35111417.8 | | | | |
| Operating & Support (O&S) | | | | | | |
| | | | | | | |
| | MOUT | 12,099,000 | 12,099,000 | 12,099,000 | 12,099,000 | 12,099,000 |
| | DSS | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 |
| | | | | | | |
| | Savings | 12,089,800 | 12,089,800 | 12,089,800 | 12,089,800 | 12,089,800 |
| | | | | | | |
| | Present Value (df @ 0%) | 12089800 | 12089800 | 12089800 | 12089800 | 12089800 |
| | Present Value (df @ 1%) | 11970099 | 11851583.2 | 11734240.8 | 11618060.2 | 11503029.9 |
| | Present Value (df @ 3%) | 11737669.9 | 11395796 | 11063879.6 | 10741630.7 | 10428767.7 |
| | Present Value (df @ 5%) | 11514095.2 | 10965805 | 10443623.8 | 9946308.38 | 9472674.65 |
| | | | | | | |
| | Net Present Value @ 0 % (NPV) | 60449000 | | | | |
| | Net Present Value @ 1 % (NPV) | 58677013 | | | | |
| | Net Present Value @ 3 % (NPV) | 55367744 | | | | |
| | Net Present Value @ 5 % (NPV) | 52342507.1 | | | | |

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# APPENDIX C DATA MOUT VS. DSCTT (10-YEAR) – USMC

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R&D | 750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 16,560 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 17310 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 0%) | 17310 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 17138.61386 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 16805.82524 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 16485.71429 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Net Present Value @ 0% (NPV) | 17310 | | | | | | | | | |
| | Net Present Value @ 1% (NPV) | 17138.61386 | | | | | | | | | |
| | Net Present Value @ 3% (NPV) | 16805.82524 | | | | | | | | | |
| | Net Present Value @ 5% (NPV) | 16485.71429 | | | | | | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | DSS | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| | Savings | 12,099 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 |
| | Present Value (df @ 0%) | 12099 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 |
| | Present Value (df @ 1%) | 11979.20792 | 11851.58318 | 11734.24077 | 11618.06017 | 11503.02987 | 11389.13849 | 11276.37474 | 11164.72746 | 11054.18561 | 10944.73822 |
| | Present Value (df @ 3%) | 11746.60194 | 11395.79602 | 11063.87963 | 10741.63071 | 10428.76768 | 10125.01717 | 9830.113754 | 9543.799761 | 9265.825011 | 8995.946612 |
| | Present Value (df @ 5%) | 11522.85714 | 10965.80499 | 10443.6238 | 9946.30838 | 9472.674647 | 9021.594902 | 8591.995145 | 8182.852519 | 7793.192875 | 7422.088453 |
| | Net Present Value @ 0 % (NPV) | 120907.2 | | | | | | | | | |
| | Net Present Value @ 1 % (NPV) | 114515.2864 | | | | | | | | | |
| | Net Present Value @ 3 % (NPV) | 103137.3783 | | | | | | | | | |
| | Net Present Value @ 5 % (NPV) | 93362.99285 | | | | | | | | | |

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# APPENDIX D DATA MOUT VS. DSCTT (10-YEAR) – ARMY

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R&D | 750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 12,328 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 13078 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 0%) | 13078 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 12948.51485 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 12697.08738 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 12455.2381 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Net Present Value @ 0% (NPV) | 13078 | | | | | | | | | |
| | Net Present Value @ 1% (NPV) | 12948.51485 | | | | | | | | | |
| | Net Present Value @ 3% (NPV) | 12697.08738 | | | | | | | | | |
| | Net Present Value @ 5% (NPV) | 12455.2381 | | | | | | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | DSS | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| | Savings | 12,099 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 | 12,090 |
| | Present Value (df @ 0%) | 12099 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 | 12089.8 |
| | Present Value (df @ 1%) | 11979.20792 | 11851.58318 | 11734.24077 | 11618.06017 | 11503.02987 | 11389.13849 | 11276.37474 | 11164.72746 | 11054.18561 | 10944.73822 |
| | Present Value (df @ 3%) | 11746.60194 | 11395.79602 | 11063.87963 | 10741.63071 | 10428.76768 | 10125.01717 | 9830.113754 | 9543.799761 | 9265.825011 | 8995.946612 |
| | Present Value (df @ 5%) | 11522.85714 | 10965.80499 | 10443.6238 | 9946.30838 | 9472.674647 | 9021.594902 | 8591.995145 | 8182.852519 | 7793.192875 | 7422.088453 |
| | Net Present Value @ 0 % (NPV) | 120907.2 | | | | | | | | | |
| | Net Present Value @ 1 % (NPV) | 114515.2864 | | | | | | | | | |
| | Net Present Value @ 3 % (NPV) | 103137.3783 | | | | | | | | | |
| | Net Present Value @ 5 % (NPV) | 93362.99285 | | | | | | | | | |

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# APPENDIX E DATA MOUT VS. VIRTSIM (5-YEAR) – USMC

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 |
|---|---|---|---|---|---|---|
| | R&D | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 3,413 | 0 | 0 | 0 | 0 |
| | Total | 3412.92 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 0%) | 3412.92 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 3379.128713 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 3313.514563 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 3250.4 | 0 | 0 | 0 | 0 |
| | Net Present Value @ 0% (NPV) | 3412.92 | | | | |
| | Net Present Value @ 1% (NPV) | 3379.128713 | | | | |
| | Net Present Value @ 3% (NPV) | 3313.514563 | | | | |
| | Net Present Value @ 5% (NPV) | 3250.4 | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | VIRTSIM | 0 | 341 | 341 | 341 | 341 |
| | Savings | 12,099 | 11,758 | 11,758 | 11,758 | 11,758 |
| | Present Value (df @ 0%) | 12099 | 11757.708 | 11757.708 | 11757.708 | 11757.708 |
| | Present Value (df @ 1%) | 11979.20792 | 11526.0347 | 11411.91555 | 11298.92628 | 11187.05573 |
| | Present Value (df @ 3%) | 11746.60194 | 11082.76746 | 10759.96841 | 10446.57127 | 10142.30221 |
| | Present Value (df @ 5%) | 11522.85714 | 10664.58776 | 10156.75024 | 9673.095469 | 9212.471876 |
| | Net Present Value @ 0 % (NPV) | 59129.832 | | | | |
| | Net Present Value @ 1 % (NPV) | 57403.14018 | | | | |
| | Net Present Value @ 3 % (NPV) | 54178.21129 | | | | |
| | Net Present Value @ 5 % (NPV) | 51229.76249 | | | | |

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# APPENDIX F DATA MOUT VS. VIRTSIM (5-YEAR) – ARMY

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 |
|---|---|---|---|---|---|---|
| | R&D | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 3,413 | 0 | 0 | 0 | 0 |
| | Total | 3412.92 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 0%) | 3412.92 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 3379.128713 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 3313.514563 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 3250.4 | 0 | 0 | 0 | 0 |
| | Net Present Value @ 0% (NPV) | 3412.92 | | | | |
| | Net Present Value @ 1% (NPV) | 3379.128713 | | | | |
| | Net Present Value @ 3% (NPV) | 3313.514563 | | | | |
| | Net Present Value @ 5% (NPV) | 3250.4 | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | VIRTSIM | 0 | 341 | 341 | 341 | 341 |
| | Savings | 12,099 | 11,758 | 11,758 | 11,758 | 11,758 |
| | Present Value (df @ 0%) | 12099 | 11757.708 | 11757.708 | 11757.708 | 11757.708 |
| | Present Value (df @ 1%) | 11979.20792 | 11526.0347 | 11411.91555 | 11298.92628 | 11187.05573 |
| | Present Value (df @ 3%) | 11746.60194 | 11082.76746 | 10759.96841 | 10446.57127 | 10142.30221 |
| | Present Value (df @ 5%) | 11522.85714 | 10664.58776 | 10156.75024 | 9673.095469 | 9212.471876 |
| | Net Present Value @ 0 % (NPV) | 59129.832 | | | | |
| | Net Present Value @ 1 % (NPV) | 57403.14018 | | | | |
| | Net Present Value @ 3 % (NPV) | 54178.21129 | | | | |
| | Net Present Value @ 5 % (NPV) | 51229.76249 | | | | |

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# APPENDIX G DATA MOUT VS. VIRTSIM (10-YEAR) – USMC

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R&D | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 3,413 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 3412.92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | |
| | Present Value (df @ 0%) | 3412.92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 3379.128713 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 3313.514563 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 3250.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | |
| | Net Present Value @ 0% (NPV) | 3412.92 | | | | | | | | | |
| | Net Present Value @ 1% (NPV) | 3379.128713 | | | | | | | | | |
| | Net Present Value @ 3% (NPV) | 3313.514563 | | | | | | | | | |
| | Net Present Value @ 5% (NPV) | 3250.4 | | | | | | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | VIRTSIM | 0 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 |
| | | | | | | | | | | | |
| | Savings | 12,099 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 |
| | | | | | | | | | | | |
| | Present Value (df @ 0%) | 12099 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 |
| | Present Value (df @ 1%) | 11979.20792 | 11526.0347 | 11411.91555 | 11298.92628 | 11187.05573 | 11076.2928 | 10966.62653 | 10858.04607 | 10750.54067 | 10644.09967 |
| | Present Value (df @ 3%) | 11746.60194 | 11082.76746 | 10759.96841 | 10446.57127 | 10142.30221 | 9846.895345 | 9560.092568 | 9281.64327 | 9011.304145 | 8748.838976 |
| | Present Value (df @ 5%) | 11522.85714 | 10664.58776 | 10156.75024 | 9673.095469 | 9212.471876 | 8773.782739 | 8355.983561 | 7958.079582 | 7579.123411 | 7218.212772 |
| | | | | | | | | | | | |
| | Net Present Value @ 0 % (NPV) | 117918.372 | | | | | | | | | |
| | Net Present Value @ 1 % (NPV) | 111698.7459 | | | | | | | | | |
| | Net Present Value @ 3 % (NPV) | 100626.9856 | | | | | | | | | |
| | Net Present Value @ 5 % (NPV) | 91114.94455 | | | | | | | | | |

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# APPENDIX H DATA MOUT VS. VIRTSIM (10-YEAR) – ARMY

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R&D | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 3,413 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 3412.92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | |
| | Present Value (df @ 0%) | 3412.92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 3379.128713 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 3313.514563 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 3250.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | |
| | Net Present Value @ 0% (NPV) | 3412.92 | | | | | | | | | |
| | Net Present Value @ 1% (NPV) | 3379.128713 | | | | | | | | | |
| | Net Present Value @ 3% (NPV) | 3313.514563 | | | | | | | | | |
| | Net Present Value @ 5% (NPV) | 3250.4 | | | | | | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | | | | | | |
| | | | | | | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | VIRTSIM | 0 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 |
| | | | | | | | | | | | |
| | Savings | 12,099 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 | 11,758 |
| | | | | | | | | | | | |
| | Present Value (df @ 0%) | 12099 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 | 11757.708 |
| | Present Value (df @ 1%) | 11979.20792 | 11526.0347 | 11411.91555 | 11298.92628 | 11187.05573 | 11076.2928 | 10966.62653 | 10858.04607 | 10750.54067 | 10644.09967 |
| | Present Value (df @ 3%) | 11746.60194 | 11082.76746 | 10759.96841 | 10446.57127 | 10142.30221 | 9846.895345 | 9560.092568 | 9281.64327 | 9011.304145 | 8748.838976 |
| | Present Value (df @ 5%) | 11522.85714 | 10664.58776 | 10156.75024 | 9673.095469 | 9212.471876 | 8773.782739 | 8355.983561 | 7958.079582 | 7579.123411 | 7218.212772 |
| | | | | | | | | | | | |
| | Net Present Value @ 0 % (NPV) | 117918.372 | | | | | | | | | |
| | Net Present Value @ 1 % (NPV) | 111698.7459 | | | | | | | | | |
| | Net Present Value @ 3 % (NPV) | 100626.9856 | | | | | | | | | |
| | Net Present Value @ 5 % (NPV) | 91114.94455 | | | | | | | | | |

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# APPENDIX I DATA MOUT VS. SPIRAL 1 (5-YEAR) – USMC

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 |
|---|---|---|---|---|---|---|
| | R&D | 120.175 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 9,900 | 0 | 0 | 0 | 0 |
| | Total | 10020.175 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 0%) | 10020.175 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 9920.965347 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 9728.325243 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 9543.02381 | 0 | 0 | 0 | 0 |
| | Net Present Value @ 0% (NPV) | 10020.175 | | | | |
| | Net Present Value @ 1% (NPV) | 9920.965347 | | | | |
| | Net Present Value @ 3% (NPV) | 9728.325243 | | | | |
| | Net Present Value @ 5% (NPV) | 9543.02381 | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | Spiral 1 | 0 | 10 | 10 | 10 | 10 |
| | Savings | 12,099 | 12,089 | 12,089 | 12,089 | 12,089 |
| | Present Value (df @ 0%) | 12099 | 12089.1 | 12089.1 | 12089.1 | 12089.1 |
| | Present Value (df @ 1%) | 11979.20792 | 11850.89697 | 11733.56136 | 11617.38748 | 11502.36384 |
| | Present Value (df @ 3%) | 11746.60194 | 11395.13621 | 11063.23903 | 10741.00877 | 10428.16386 |
| | Present Value (df @ 5%) | 11522.85714 | 10965.17007 | 10443.01911 | 9945.732488 | 9472.126179 |
| | Net Present Value @ 0 % (NPV) | 60455.4 | | | | |
| | Net Present Value @ 1 % (NPV) | 58683.41758 | | | | |
| | Net Present Value @ 3 % (NPV) | 55374.14981 | | | | |
| | Net Present Value @ 5 % (NPV) | 52348.90499 | | | | |

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# APPENDIX J DATA MOUT VS. SPIRAL 1 (5-YEAR) – ARMY

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 |
|---|---|---|---|---|---|---|
| | R&D | 120.175 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 7,370 | 0 | 0 | 0 | 0 |
| | Total | 7490.175 | 0 | 0 | 0 | 0 |
| | | | | | | |
| | Present Value (df @ 0%) | 7490.175 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 7416.014851 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 7272.014563 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 7133.5 | 0 | 0 | 0 | 0 |
| | | | | | | |
| | Net Present Value @ 0% (NPV) | 7490.175 | | | | |
| | Net Present Value @ 1% (NPV) | 7416.014851 | | | | |
| | Net Present Value @ 3% (NPV) | 7272.014563 | | | | |
| | Net Present Value @ 5% (NPV) | 7133.5 | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | |
| | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | Spiral 1 | 0 | 6 | 6 | 6 | 6 |
| | | | | | | |
| | Savings | 12,099 | 12,094 | 12,094 | 12,094 | 12,094 |
| | | | | | | |
| | Present Value (df @ 0%) | 12099 | 12093.5 | 12093.5 | 12093.5 | 12093.5 |
| | Present Value (df @ 1%) | 11979.20792 | 11855.21027 | 11737.83195 | 11621.6158 | 11506.55029 |
| | Present Value (df @ 3%) | 11746.60194 | 11399.28363 | 11067.26566 | 10744.91811 | 10431.95933 |
| | Present Value (df @ 5%) | 11522.85714 | 10969.161 | 10446.82 | 9949.352379 | 9475.573694 |
| | | | | | | |
| | Net Present Value @ 0 % (NPV) | 60473 | | | | |
| | Net Present Value @ 1 % (NPV) | 58700.41624 | | | | |
| | Net Present Value @ 3 % (NPV) | 55390.02867 | | | | |
| | Net Present Value @ 5 % (NPV) | 52363.76421 | | | | |

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# APPENDIX K DATA MOUT VS. SPIRAL 1 (10-YEAR) – USMC

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R&D | 120.175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 9,900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 10020.175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | |
| | Present Value (df @ 0%) | 10020.175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 9920.965347 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 9728.325243 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 9543.02381 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | |
| | Net Present Value @ 0% (NPV) | 10020.175 | | | | | | | | | |
| | Net Present Value @ 1% (NPV) | 9920.965347 | | | | | | | | | |
| | Net Present Value @ 3% (NPV) | 9728.325243 | | | | | | | | | |
| | Net Present Value @ 5% (NPV) | 9543.02381 | | | | | | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | Spiral 1 | 0 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | | | | | | | | | | | |
| | Savings | 12,099 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 |
| | | | | | | | | | | | |
| | Present Value (df @ 0%) | 12099 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 |
| | Present Value (df @ 1%) | 11979.20792 | 11855.21027 | 11737.83195 | 11621.6158 | 11506.55029 | 11392.62405 | 11279.82579 | 11168.14435 | 11057.56866 | 10948.08779 |
| | Present Value (df @ 3%) | 11746.60194 | 11399.28363 | 11067.26566 | 10744.91811 | 10431.95933 | 10128.11586 | 9833.122192 | 9546.720575 | 9268.660753 | 8998.69976 |
| | Present Value (df @ 5%) | 11522.85714 | 10969.161 | 10446.82 | 9949.352379 | 9475.573694 | 9024.355899 | 8594.624666 | 8185.356825 | 7795.577928 | 7424.359932 |
| | | | | | | | | | | | |
| | Net Present Value @ 0 % (NPV) | 120940.5 | | | | | | | | | |
| | Net Present Value @ 1 % (NPV) | 114546.6669 | | | | | | | | | |
| | Net Present Value @ 3 % (NPV) | 103165.3478 | | | | | | | | | |
| | Net Present Value @ 5 % (NPV) | 93388.03946 | | | | | | | | | |

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# APPENDIX L DATA MOUT VS. SPIRAL 1 (10-YEAR) – ARMY

| INVESTMENT (FY08$K Constant) | | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R&D | 120.175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Procurement (1 year) | 7,370 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 7490.175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 0%) | 7490.175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 1%) | 7416.014851 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 3%) | 7272.014563 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Present Value (df @ 5%) | 7133.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Net Present Value @ 0% (NPV) | 7490.175 | | | | | | | | | |
| | Net Present Value @ 1% (NPV) | 7416.014851 | | | | | | | | | |
| | Net Present Value @ 3% (NPV) | 7272.014563 | | | | | | | | | |
| | Net Present Value @ 5% (NPV) | 7133.5 | | | | | | | | | |
| Operating & Support (O&S) (FY08$K Constant) | | | | | | | | | | | |
| | MOUT | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 | 12,099 |
| | Spiral 1 | 0 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | Savings | 12,099 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 | 12,094 |
| | Present Value (df @ 0%) | 12099 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 | 12093.5 |
| | Present Value (df @ 1%) | 11979.20792 | 11855.21027 | 11737.83195 | 11621.6158 | 11506.55029 | 11392.62405 | 11279.82579 | 11168.14435 | 11057.56866 | 10948.08779 |
| | Present Value (df @ 3%) | 11746.60194 | 11399.28363 | 11067.26566 | 10744.91811 | 10431.95933 | 10128.11586 | 9833.122192 | 9546.720575 | 9268.660753 | 8998.69976 |
| | Present Value (df @ 5%) | 11522.85714 | 10969.161 | 10446.82 | 9949.352379 | 9475.573694 | 9024.355899 | 8594.624666 | 8185.356825 | 7795.577928 | 7424.359932 |
| | Net Present Value @ 0 % (NPV) | 120940.5 | | | | | | | | | |
| | Net Present Value @ 1 % (NPV) | 114546.6669 | | | | | | | | | |
| | Net Present Value @ 3 % (NPV) | 103165.3478 | | | | | | | | | |
| | Net Present Value @ 5 % (NPV) | 93388.03946 | | | | | | | | | |

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